

O Level Pure Chemistry Structured

Organic Chemistry Test 2.0

Q1

B9 Polystyrene and Kevlar are examples of useful synthetic polymers.

Polystyrene is an addition polymer used as a foam material.

Kevlar is a condensation polymer used to make bullet proof vests.

(a) Describe the differences between addition polymers and condensation polymers.

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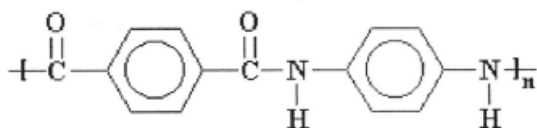
.....

.....

[3]

(b) Diagram 9.1 shows the repeating unit of Kevlar.

Diagram 9.1



Source: http://web.mit.edu/3.082/www/team2_f01/chemistry.html

(i) Draw the structures of the **two** monomers that react to form Kevlar.

monomer 1

monomer 2

[2]

- (ii) During the manufacturing process, the chain length of Kevlar is controlled so that the Kevlar polymer molecules have an average relative molecular mass in the range of 12 000 to 20 000.



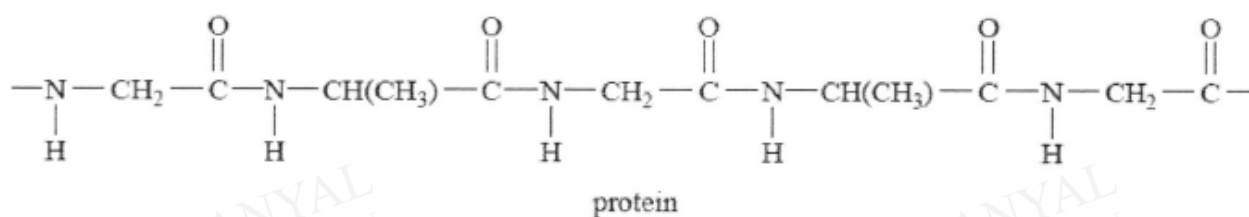
Each (known as a benzene ring) is made up of 6 carbon atoms and 6 hydrogen atoms.

What is the range of the average number of repeating units in the Kevlar molecules?
Show your working.

[2]

- (c) Proteins are also condensation polymers.
Diagram 9.2 shows the structure of a protein, which is made from two monomers.

Diagram 9.2



- (i) Draw the structure for **one** of the monomers of the protein in diagram 9.2.

[1]

(ii) Give one similarity and one difference between the structures of Kevlar (diagram 9.1) and protein (diagram 9.2).

one similarity

.....

.....

one difference

.....

.....

[2]
[10 marks]

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Q2

A chemist has discovered a cure for smelly socks. Small particles of silver are attached to a polymer, poly(propene), and this is woven into the socks.

- (a) Draw the full structural formulae of the monomer and the polymer, poly(propene).

DANYAL EDUCATION monomer	DANYAL EDUCATION polymer
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[2]

- (b) Suggest whether the monomer or the polymer will react with aqueous bromine. Describe what you would see and explain your observations with the help of a full structural equation.

.....

.....

.....

.....

[4]

- (c) To show that the polymer, poly(propene), contains silver the following test was carried out.

The polymer fibres were chopped into small pieces and warmed with nitric acid. The silver atoms were oxidised to silver(I) ions. The mixture was filtered to get the filtrate. The filtrate contains silver nitrate.

- (i) The above test is incomplete. Using the test above, briefly describe the steps you will take to show that the polymer contains silver. State the reagent(s) you would use to help you identify the presence of silver ions.

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.....

.....

[2]

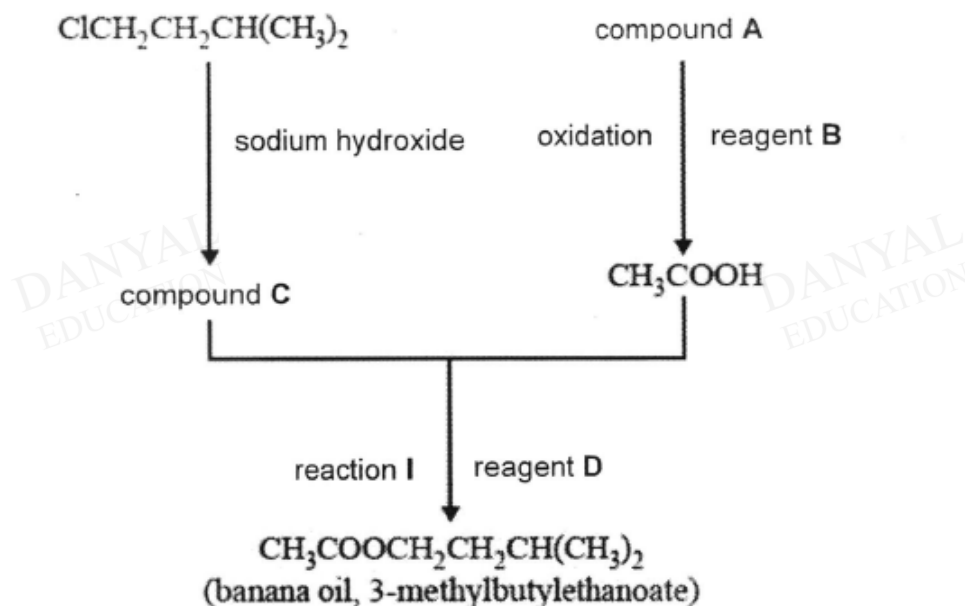
- (ii) Write an ionic equation with state symbols described in (c)(i) for the above test to identify the presence of silver ions.

..... [1]

Q3

Banana oil, 3-methylbutylethanoate, $\text{CH}_3\text{COOCH}_2\text{CH}_2\text{CH}(\text{CH}_3)_2$, is a sweet smelling liquid that gives bananas their characteristic odour.

A chemist working for Wow Bananas Pte Ltd has proposed the following reaction pathway for the synthesis of banana oil.



- (a) Name compound A and reagent B. Describe what you see when reagent B is used.

compound A: reagent B:

.....

[3]

- (b) Draw the full structural formula of compound C.

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[1]

- (c) Identify reagent D and name the process in reaction I.

reagent D:

name of process: [2]

(d) The chemist decided to separate the final product from the reaction mixture.

State the separation technique he can use to obtain a pure product and explain how it can be separated using this technique.

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.....
.....
..... [2]

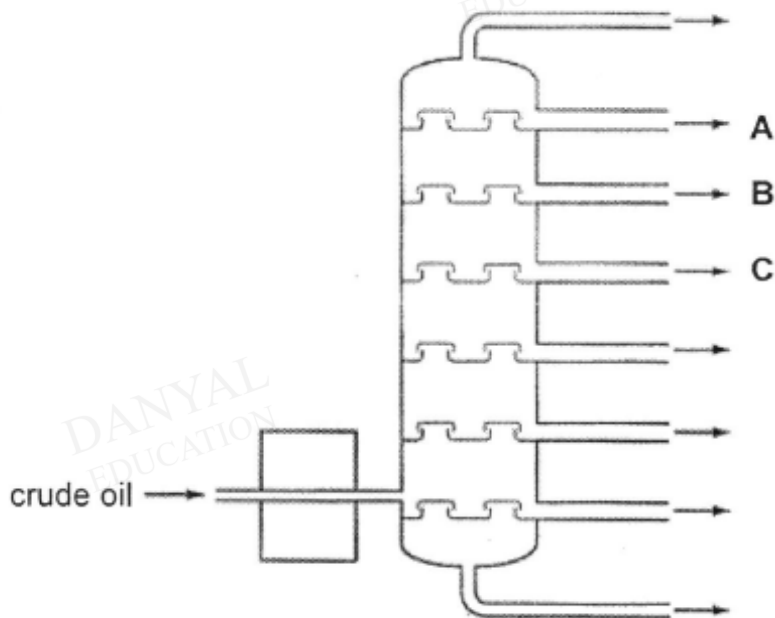
(e) Give two uses of the pure product obtained in part (d).

.....
.....
..... [2]

[Total: 10]

Q4

The diagram below shows a fractionating column for the separation of crude oil.



Cracking is carried out on **B** to produce other useful products. The table below shows some information on the percentage yield of the products from a cracking plant.

product	percentage yield (%)
methane	15
ethene	32
propene	16
C ₄ hydrocarbons	11
C ₅ to C ₈ hydrocarbons	25

- (i) Cracking is often described as a key source of alkenes. Use the information given to support the above statement.

.....
..... [1]

- (ii) Suggest a reason why the data for C₄ hydrocarbons and C₅ to C₈ hydrocarbons are grouped together, whereas the data for the first few products are classified individually.

.....
..... [2]

Q5

Alkenes are unsaturated organic compounds consisting of a carbon-carbon double bond.

Table 1 lists the boiling points of some straight chain alkenes.

alkene	boiling point (°C)
ethene	-104
propene	-47
butene	-6
pentene	30
hexene	63

Table 1

Table 2 shows the properties of branched isomers of some of the alkenes.

	number of carbon atoms in molecule	formula	boiling point (°C)
branched alkene 1	4	<pre> H H H-C - C = C H H H-C-C H </pre>	-7
branched alkene 2	5	<pre> H H H H H-C - C - C = C H H H H-C-H H </pre>	20

Table 2

(a) What trend is shown by the data in Table 1?

_____ [1]

(b) Using evidence from Tables 1 and 2, explain how the boiling point of a straight chain alkene is affected by branching in isomerism.

[3]

(c) **Q** is a gaseous hydrocarbon which can decolourise a solution of bromine and has a density of 1.75 g/dm^3 at room temperature and pressure.

(i) Calculate the relative molecular mass of **Q**.

(ii) Hence, identify **Q**. Explain your reasoning. [1]

[2]

(iii) Hence, write a chemical equation for the reaction between **Q** and bromine solution. [1]

[1]

(d) Both ethane and ethene can react with chlorine.
Give one similarity and one difference between the two reactions.

[2]

[Total: 10 marks]

Answers

Organic Chemistry Test 2.0

Q1

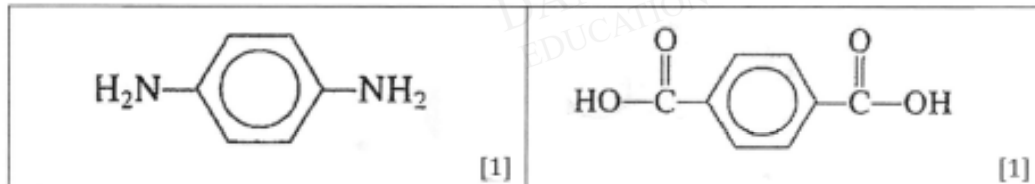
(a) For clarity of marking scheme, the answer is presented in a table.

Any 3 points

Addition polymer	Condensation polymer
Monomers must be unsaturated / contain C=C double bond. [1]	Monomers contain 2 functional groups (e.g. -COOH, -OH, -NH ₂). [1]
No loss in atoms during polymerisation. [1] or Only 1 product is formed. [1]	Loss of small molecules (e.g. water) during polymerisation. [1] or 2 products formed (i.e. polymer and small molecules). [1]
Mass of addition polymer <u>equals</u> sum of its monomers' masses. [1]	Mass of condensation polymer is <u>less than</u> sum of its monomers' masses. [1]
Polymer contains C-C linkages. [1]	Polymer contains ester <u>or</u> amide linkages. [1]

[3]

(b) (i)



(ii) Formula of repeating unit for Kevlar = C₁₄H₁₄N₂O₂

$$M_r \text{ of repeating unit for Kevlar} = (14 \times 12) + (14 \times 1) + (2 \times 14) + (2 \times 16) = 242$$

$$\text{Number of units if average mass is 12 000} = (12\,000 \div 242) = 49.6 \approx 50$$

$$\text{Number of units if average mass is 20 000} = (20\,000 \div 242) = 82.6 \approx 82$$

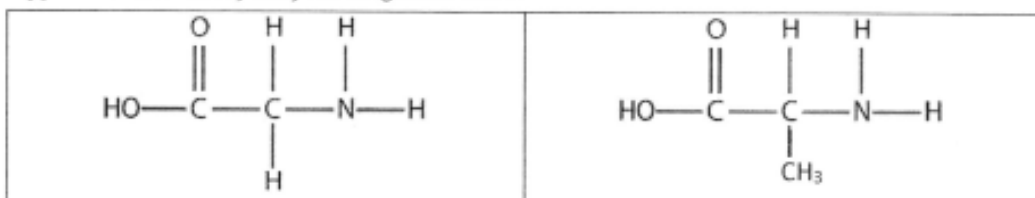
Range is between 50 to 82 repeating units.

Working [1]

Answer [1]

[2]

(c) (i) Either one of the following monomers:



[1]

(ii) Similarity - Both contain amide linkages. / Both are polyamides. [1]

Difference - Absence of benzene ring in protein. / Amide linkage is in the same order in protein but not in Kevlar. [1]

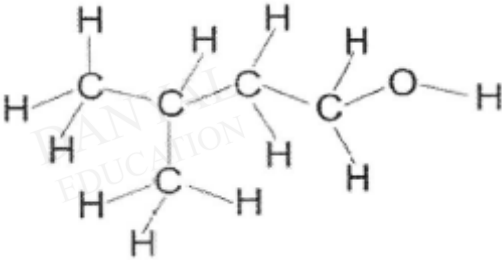
Vague answer such as 'The structures are different' is not accepted.

[10 marks]

Q2

(a)	Propene $\begin{array}{c} \text{H} & & \text{H} \\ & & \\ \text{C} = \text{C} & - & \text{C} - \text{H} \\ & & \\ \text{H} & \text{H} & \text{H} \end{array}$	Poly(propene) $\left[\begin{array}{cc} \text{H} & \text{H} \\ & \\ \text{---C} & - & \text{C---} \\ & \\ \text{H} & \text{H} \end{array} \right]_n$	[2]
(b)	The monomer will react with aqueous bromine. Reddish brown bromine solution will decolourise when added to monomer. Monomer (propene) has a C=C bond (OR is unsaturated) which can undergo addition reaction with aqueous bromine to form 1,2 dibromopropane. $\begin{array}{c} \text{H} & & \text{H} \\ & \diagdown & / \\ & \text{C} = \text{C} \\ & / & \diagdown \\ \text{CH}_3 & & \text{H} \end{array} + \text{Br}_2 \longrightarrow \begin{array}{c} \text{H} & \text{H} \\ & \\ \text{CH}_3 - \text{C} & - & \text{C} - \text{H} \\ & \\ \text{Br} & \text{Br} \end{array}$		[1] [1] [1] [1]
(c)	(i)	Add sodium chloride (or any suitable chloride solution) to the filtrate. A white precipitate , AgCl is formed. (<i>must identify the white precipitate</i>) Since a white ppt is formed , this shows that the polymer contains silver.	[1] [1]
	(ii)	$\text{Ag}^+ (\text{aq}) + \text{Cl}^- (\text{aq}) \rightarrow \text{AgCl} (\text{s})$	[1]

Q3

(a)	<p>Compound A – ethanol Reagent B – acidified potassium manganate (VII)/ acidified potassium dichromate (VI)</p> <p>In acidified potassium manganate (VII), purple solution decolourised/ in acidified potassium dichromate (VI), orange solution turns green.</p>	<p>[2] [1]</p>
(b)		<p>[1]</p>
(c)	<p>Concentrated sulfuric acid</p> <p>Esterification</p>	<p>[1] [1]</p>
(d)	<p>Fractional distillation</p> <p>Heat the mixture to vaporize the fractions</p> <p>The final product will be distilled as it has different boiling point with lower boiling point will be collected as distillate first,</p> <p>Followed by the fraction with higher boiling point</p>	<p>[1] [1]</p>
(e)	<p>The two uses of esters are:</p> <p>Food flavourings/ Solvents used in perfumes/ manufacture of soaps (choose any 2)</p>	<p>[2]</p>

Q4

(i)	<p>For both processes, the <u>yield of ethene and propene alone</u> (excluding the alkenes in the C₄ to C₈ hydrocarbons), <u>accounts for 48%</u>.</p>	<p>1</p>
(ii)	<p>From C₄ onwards, there are <u>isomers for both the alkanes and alkenes</u>. Hence there are many compounds with the same number of carbon atoms.</p> <p>The <u>smaller hydrocarbons have no isomers</u>, so they are classified individually.</p>	<p>1 1</p>

Q5

(a)	The greater the number of C atoms/ the larger the molecule/ down the series, the higher the boiling point;	1
(b)	Branching in isomerism <u>decreases</u> the boiling point of straight chain alkenes; From the data, the boiling point of straight chain butene (-6 °C) is higher than the branched butene (-7 °C); The boiling point of straight chain pentene (30 °C) is also higher than the branched pentene (20 °C);	1 1 1
(c)	(i) Volume of Q = no. of mol of Q × 24 dm ³ (Mass/density) = (mass/Mr) × 24 dm ³ Mr = density × 24 dm ³ = 1.75 × 24 = 42 (no unit)	1
	(ii) Q is propene/ C ₃ H ₆ ; with Mr of propene = (12×3) + (1×6) = 42; <u>As Q decolourises aqueous bromine</u> , it is unsaturated/ an <u>alkene</u> with general formula C _n H _{2n} ;	1 1
	(iii) C ₃ H ₆ + Br ₂ → C ₃ H ₆ Br ₂ (allow e.c.f)	1
(d)	Similarity (any one) <ul style="list-style-type: none"> • both reactions can form dichloroethane (Accept: chloroethane) • both reactions involve formation of C-Cl bond Difference (any one) <ul style="list-style-type: none"> • substitution in ethane requires UV light whereas addition in ethene does not require. • substitution in ethane involve breaking of C-H bond whereas addition in ethene does not. • substitution in ethane produces many products whereas addition in ethene produces only one product (dichloroethane). • substitution in ethane produces a byproduct (HCl or H₂) whereas addition in ethene does not. or any reasonable answers which include comparison of both reactions.	1 1

OR